

cosines respectively, of the apparent magnetic bearings of the distant object, observed with the ship's head successively on the sixteen principal points of the compass (or on eight principal points, as the case may be). He considers that this method may prove useful in magnetic surveys of the ocean.

Additional remarks to the foregoing paper. Received April 14, 1853.

In consequence of a suggestion of Professor William Thomson, the author here investigates the modifications required in the formulæ of the previous part of his paper, when the compass-needle produces by induction a sensible effect on the mutual magnetic action of the earth and the ship.

Let A , as in Mr. Archibald Smith's formulæ, represent the mean of the sines of the deviations of the compass-needle observed during a complete revolution of the ship. As there is reason to believe that this quantity does not vary for a given ship in different parts of the earth so long as the quantity and distribution of her iron are unchanged, it may be determined, once for all, while in port, in the usual way.

When the ship is out of reach of land, let s be the mean of the sines, and c the mean of the cosines, of the apparent magnetic azimuths of a distant object observed during a complete revolution of the ship. Then the sine of the true magnetic azimuth of the object is given by the formula

$$\sin \alpha = \frac{s \sqrt{(c^2 + s^2 - A^2)} - cA}{c^2 + s^2}.$$

When $A=0$, this formula becomes

$$\tan \alpha = \frac{s}{c},$$

being identical with that of the previous part of this paper.

May 12, 1853.

The EARL OF ROSSE, President, in the Chair.

In compliance with the Statutes, it was announced from the Chair, that the following Candidates are recommended by the Council for election into the Society:—

James Apjohn, M.D.
John George Appold, Esq.
John Allan Broun, Esq.
Antoine Jean François Claudet,
Esq.
Edward J. Cooper, Esq.
E. Frankland, Esq.
John Hall Gladstone, Esq.
Joseph Beete Jukes, Esq.

Robert MacAndrew, Esq.
Charles Manby, Esq.
Joseph Prestwich, Esq.
William John Macquorn Rankine, Esq.
William Wilson Saunders, Esq.
William Spottiswoode, Esq.
Count P. de Strzelecki.

A paper was read, entitled "A few Remarks on Currents in the Arctic Seas." By P. C. Sutherland, M.D. Communicated by Colonel Sykes, F.R.S. &c. Received April 16, 1853.

The author states that, during a voyage lately made in the Arctic seas, his attention was arrested by the power exerted by refrigeration and congelation in separating from water any saline ingredients it may contain, and of thus causing disturbances in the mean density of the waters of the ocean, which, after being influenced by currents, can be overcome only by subsequent intermixture with water from other localities where the disturbance in the equilibrium is of an opposite character. He considers that evaporation, which is so active within the tropical and temperate zones, obviously renders the sea more dense by depressing its surface, and thus gives rise to the necessity for currents from the two poles of the earth, where deposition of vapour predominates to a considerable extent over evaporation. This he illustrates by referring to the constant current from the Atlantic into the Mediterranean, caused by the evaporation in this sea preponderating over the supply of fresh-water. He then points out the necessity also of a current out of this sea, in order that its waters, by the constant influx of saline matters, may not become a saturated solution of the salts of the ocean; and infers that counter-currents into the polar seas must also exist to obviate the contrary tendency which the waters of these seas have to become fresh. He calls attention to the importance of ascertaining the differences that occur in many parts of the surface of the ocean in respect to its saline contents, that we may be enabled to determine to what extent the currents and counter-currents may be influenced by the comparative freshness of the iced water of the northern and southern regions, and the necessary saltiness of the equatorial and other overheated basins. On this point, with respect to the Arctic seas, he refers to observations by Dr. Scoresby, Sir Edward Parry, and those recorded in tables appended to this paper, which have been extracted from the Meteorological Journal kept in the North Atlantic and Davis's Straits during the late voyage in the *Isabel*.

The author next refers to the remarkable difference occurring in the climate of the east and west sides of Davis's Straits, that of the latter being much the colder. In the absence of thermometric registers for the west, to compare with those on the east side, he points out how the appearance of the land and development of plants and land animals on the two coasts enable us to determine which has the warmer climate. Looking from the top of Baffin's Bay, which commands a good view of both shores, the east side at the sea-coast has many portions of land free from snow, whereas the opposite, by its snowy and icy covering, presents an appearance altogether uncongenial. On the former are found a tolerably abundant flora, hares and deer; on the latter, there scarce appears to be a spot to receive the roots of plants or the feet of these animals; and in the productions of the sea, both vegetable and animal, the same disproportion is met with. Upon the whole, he considers complete the analogy that exists between the North Atlantic and Davis's Straits,

both with respect to the climate of their shores and to their inhabitants of the animal and vegetable kingdoms. With reference to the question how this analogy is brought about, the author considers it difficult to decide whether the increase in the temperature of the water and the consequent improvement of the climate, on the east side of the strait, arise from the disposition the ice has to leave the coast, by which means the water becomes exposed to the influence of the sun; or from currents of heated water from a more southern region. He further remarks that its density here cannot be restored, if once disturbed, without admixture with a large volume of water somewhat above the mean density.

Again referring to the observations of Sir Edward Parry and those recorded in the tables, the author remarks that from these it will be seen that refrigeration has the effect of precipitating the salts of sea-water; and further, that it appears to him very probable that the temperature at which water begins to expand by the continued application of cold is that at which saline and earthy matter begins to be precipitated in solutions of the density of sea-water.

From the immense depth to which icebergs extend in Davis's Straits, and also from their vast number, the author infers that the temperature of the water will be kept pretty uniformly the same throughout a considerable part of its depth, rarely exceeding $+32^{\circ}$, except at the surface, where the action of the sun comes into operation, in which case the water of greatest density from saline contents would always occupy the lowest position. In illustration of his views, he describes experiments on the freezing of sea-water of the density 1.025, in glass tubes; and from these he infers that, not only does congelation precipitate the saline matter in water, but refrigeration also at temperatures from 40° down to 32° . With reference to the influence of the density of the sea-water on currents, he remarks that after the warm season has fairly set in, in the Arctic seas, nothing is more common than to observe the surface-water, in hollowed out lanes or fissures of the land-ice, moving slowly towards the open water at the edge of the fixed ice; and this seaward motion is altogether independent of tidal motion or oceanic current, depending entirely upon the diminished density of the surface-water.

In conclusion, the author states that he does not know that we are yet in a position to demonstrate the actual existence of currents *into* the icy seas, as well as *out* of them; but that the necessity for them is obvious. It is not necessary, he remarks, that these currents, as in other parts, should occupy the surface, and probably also the bottom of one of the sides of the basins whose waters require to be renewed, as the Gulf-stream occupies the east side of the North Atlantic. It is plain that the cold and hot waters of two regions can be exchanged by the latter passing underneath the former; and although the arctic current from the Greenland sea does not contain much ice to the southward of Cape Farewell, it is more than probable its chilly waters pass over a fork of the Gulf-stream, which ultimately sweeps along the shores of West Greenland.

The Society then adjourned to the 26th of May.